

HIDDEN KERNEL MODULE DISCOVERY MODEL

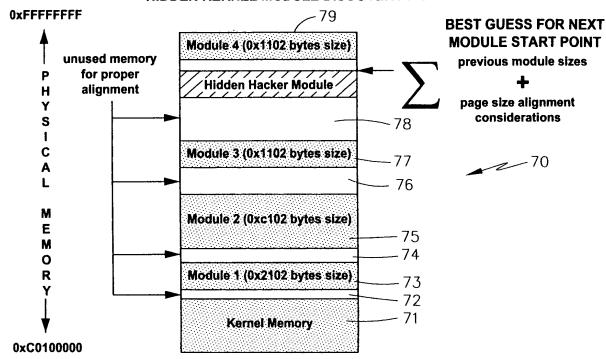


Fig.7

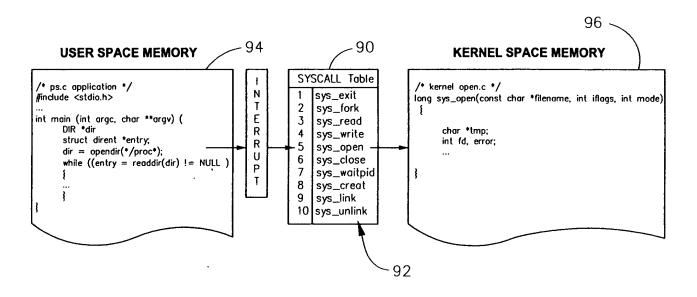
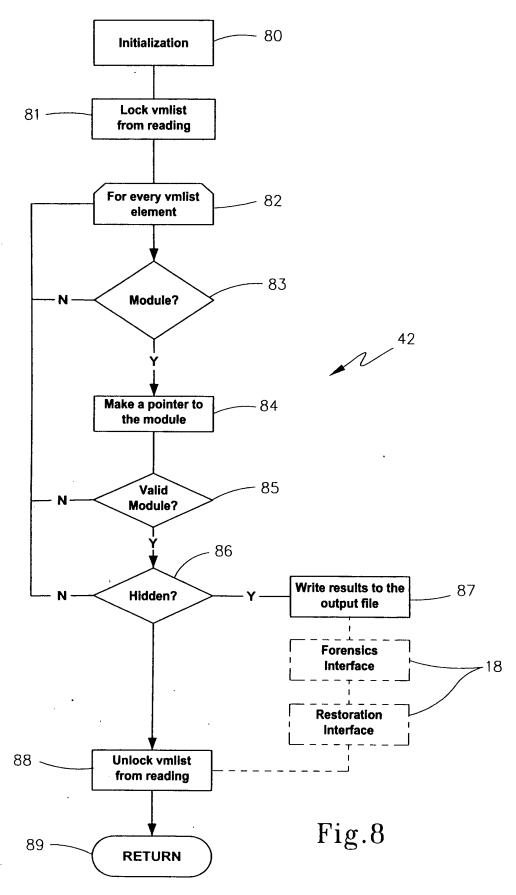
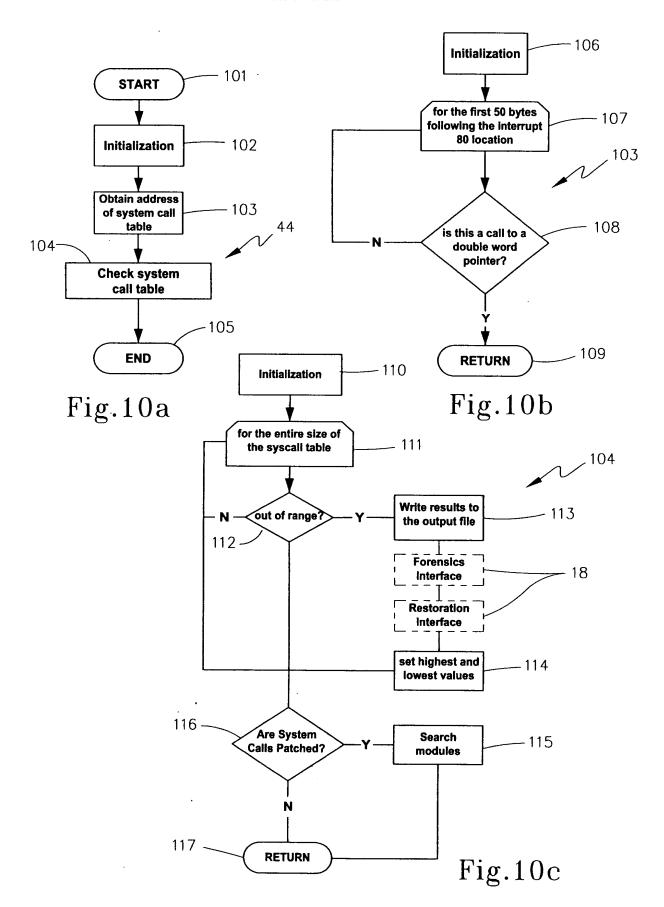
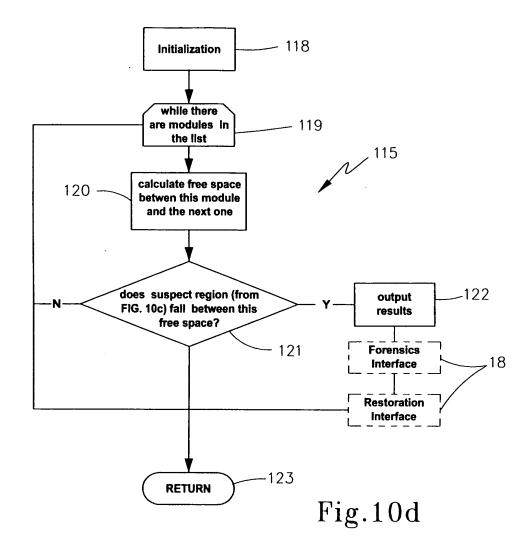


Fig.9



Docket No.: 2037





IDENTIFIED SYSCALL ANOMALIES CAUSE BY ADORE v0.42

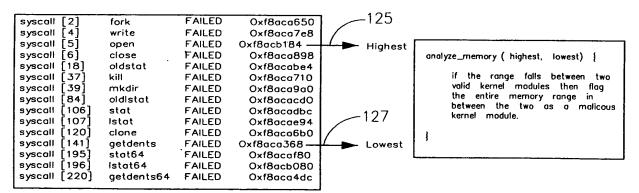
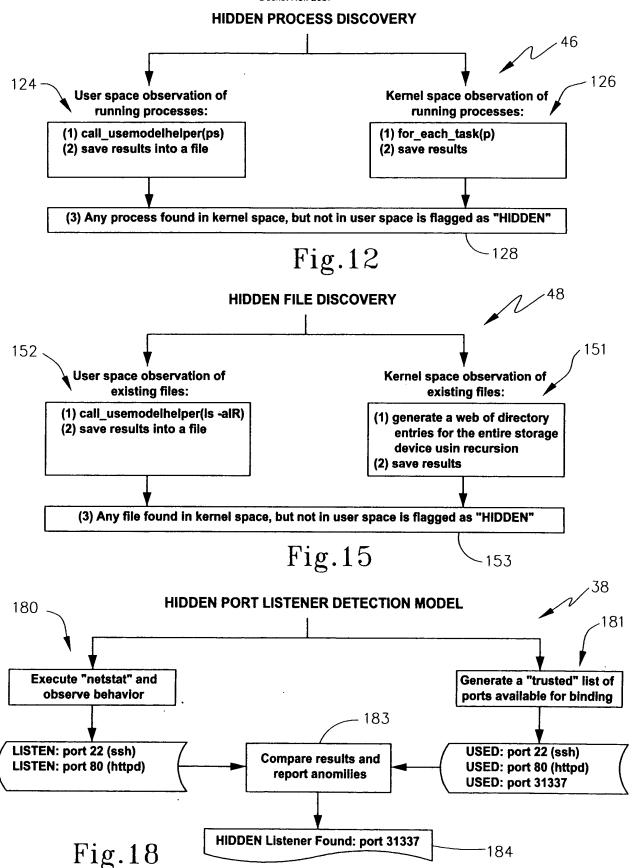
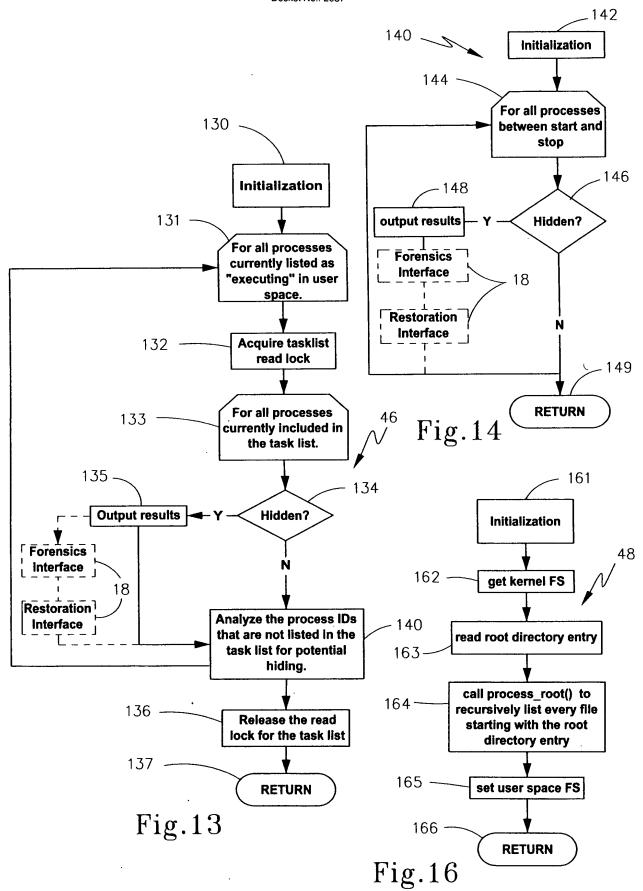


Fig. 11





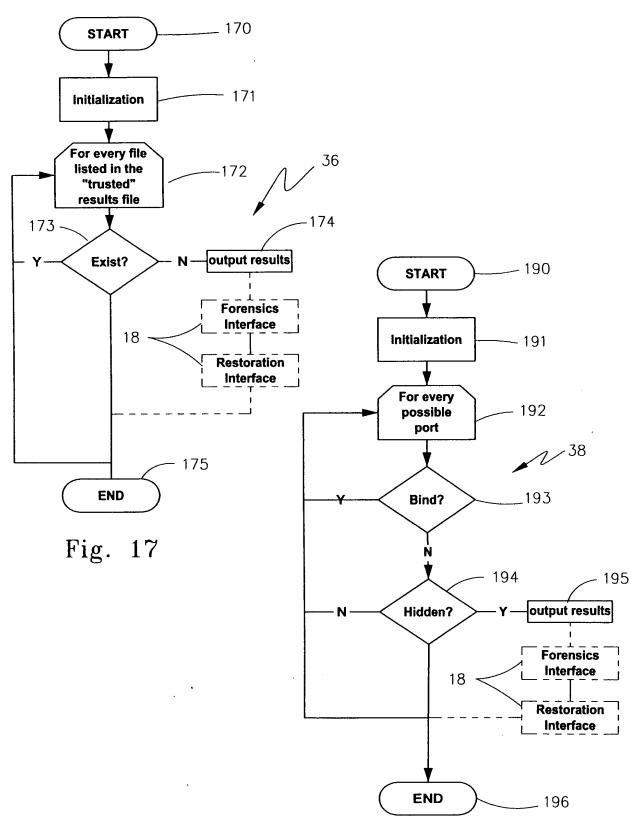


FIG. 19

```
Script started on Sat Aug _9 15:42:00 2003
[root@localhost interrogator]# ./interrogator
Where would you like the results stored? [/tmp/interrogator/]
Check for hidden processes? [Y]
Check for hidden TCP port listeners? [Y]
                                                                                          ____ 200
Check for system call patching? [Y]
Check for hidden kernel modules? [Y]
Check for hidden files? (may take > 15 minutes) [N] Y
Running the interrogator— this may take a minute
Results are located at /tmp/interrogator/summary
View results now? [Y]
-----[ SUMMARY ]------
NO hidden modules were found.
NO system call table modifications were found.
NO hidden processes were found.
WARNING: File size is 60133 (should be 58885): /var/log/sa/sa09
WARNING: File size is 1010871 (should be 1010003): /var/log/cron WARNING: File size is 597700 (should be 597264): /var/log/maillog
NO hidden files were found.

NO hidden TCP port listeners were found.
[root@ocalhost interrogator)# exit
Script done on Sat Aug 9 16:01:52 2003
```

```
(root@localhost interrogator]# ./interrogator
Where would you like the results stored? [/tmp/interrogator/]
Check for hidden processes? [Y]
Check for hidden processes? [Y]
Check for hidden TCP port listeners? [Y]
Check for system call patching? [Y]
Check for hidden kernel modules? [Y]
Check for hidden files? (may take > 15 minutes) [N] Y
Running the interrogator— this may take a minute
Results are located at /tmp/interrogator/summary
View results now? [Y]
                                                                                          N
                                                                                                         202
View results now? [Y]
 -----[ SUMMARY ]------
NO hidden modules were found.
NO system call table modifications were found
WARNING: process id 13745 hidden or just exited (tb)
Launch Path: /root/code/interrogator/de-rojansans/tb
FOUND 1 Hidden process listing
HIDDEN file found: /tmp/hideme
WARNING: File size is 62629 (should be 61381): /var/log/sa/sa09
WARNING: File size is 1013693 (should be 1012816): /vor/log/cron WARMING: File size is 599450 (should be 599012): /var/log/maillog
HIDDEN TCP Port Listener found: port 2222
(root@localhost interrogator]# exit
```

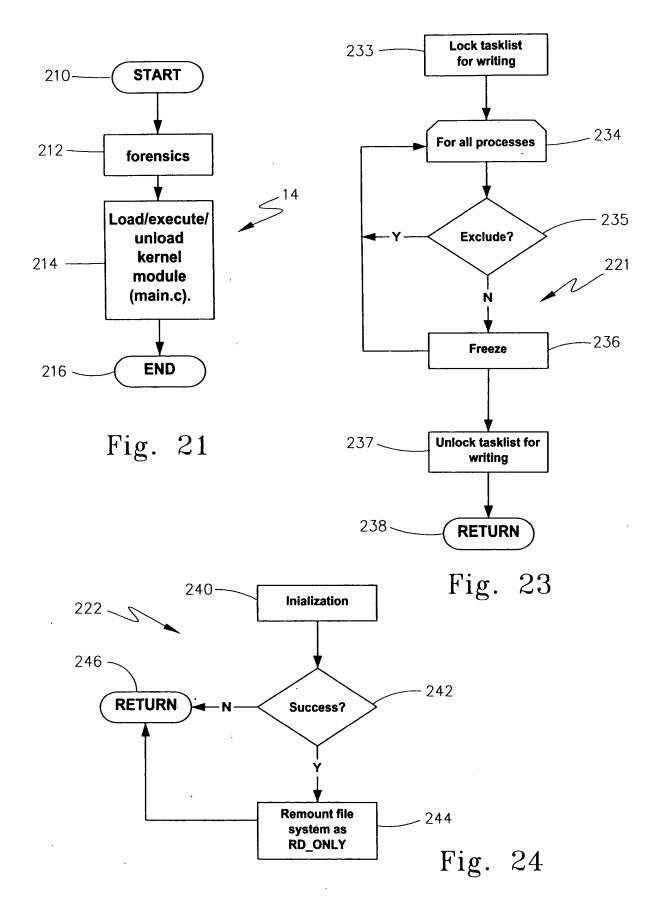
Fig.20b

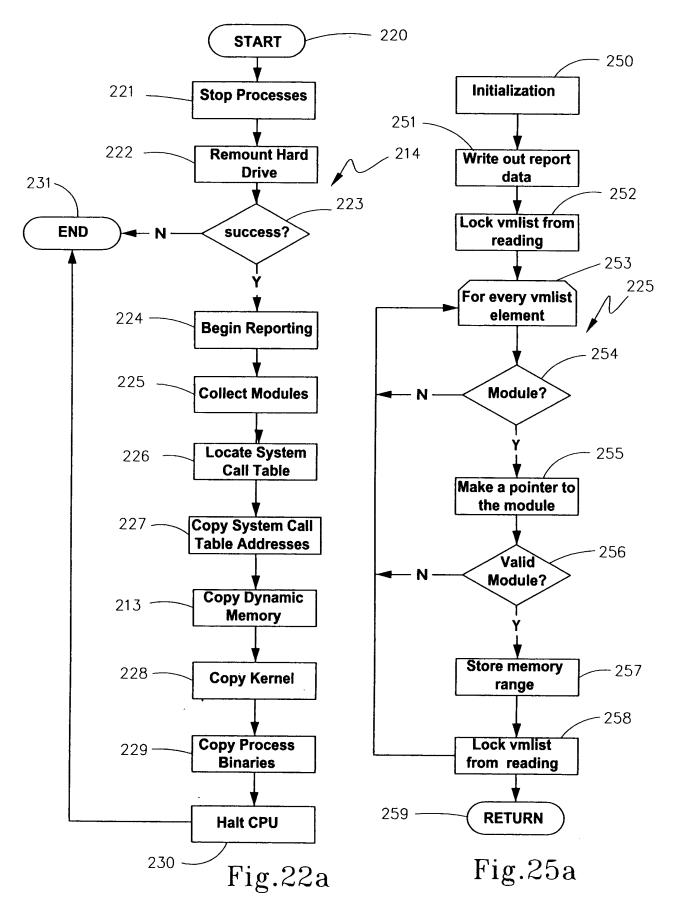
Fig.20a

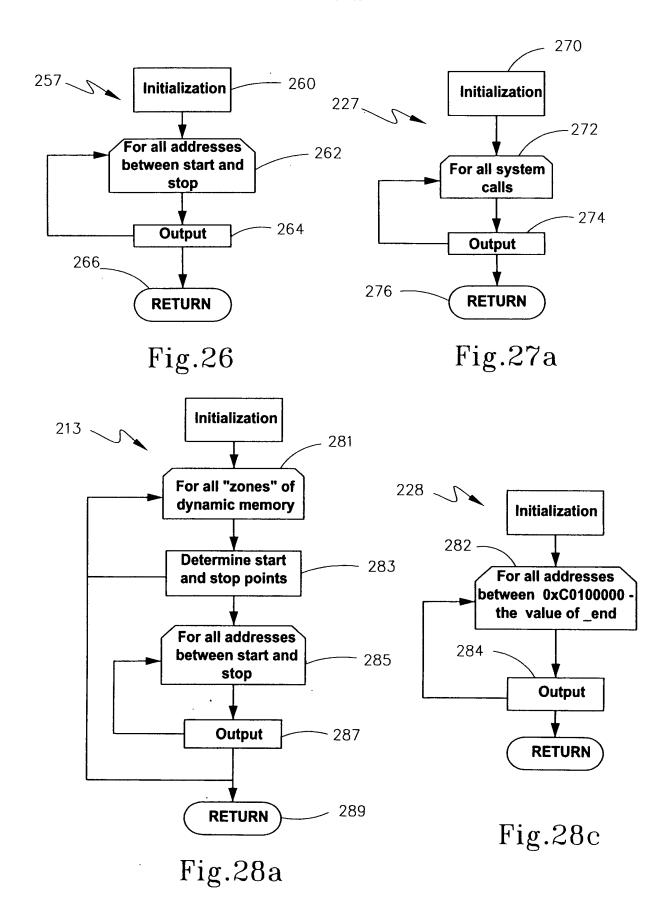
```
(root@localhost interrogator)# ./interrogator
Where would you like the results stored? [/tmp/interrogator/]
Check for hidden processes? [Y]
Check for hidden TCP port listeners? [Y]
Check for system call patching? [Y]
Check for hidden kernel modules? [Y]
Check for hidden flies? (may take > 15 minutes) [N) Y
Running the interrogator. .. this may take a minute
Results are located at /tmp/interrogator/summary
View results now? [Y]
WARNING suspect module found: f8a0f000 8000 bytes (adore)
Image stored at /tmp/interrogator/adore.o
FOUND 1 HIDDEN module loaded
 WARNING: Deviations found in the sys_call_table
                                      FAILED Oxf8a0f650
FAILED Oxf8a0f7e8
FAILED Oxf8a10184
syscoll[2]
syscoll[4]
                                                                                                                                                        204
 syscall[5]
syscall[6]
syscall[18]
                                                                                                     open
                                      FAILED
                                                          Oxf8a0f898
                                                                                                     ciose
                                                          Oxf8a0fbe4
                                                                                                     oldstot
 syscall(37
                                      FAILED
                                                          Oxf8e0f710
                                                                                                    kill
 syscall 39
                                      FAILED
                                                          0xf8a0f9a0
                                                                                                    mkdir
syscall[34]
syscall[106]
syscall[107]
syscall[120]
                                      FAILED
FAILED
                                                          Oxf8a0fcd0
                                                                                                     oldistat
                                                          OxfSaOfdbc
                                                                                                     stat
                                      FAILED
FAILED
                                                          Oxf8a0fe94
Oxf8a0f6b0
                                                                                                    Istat
                                                                                                     clone
  syscall[141]
                                      FAILED
                                                          Oxf8a0f368
                                                                                                     getdents
 syscall[195
                                       FAILED
                                                          Oxf8aOff80
                                                                                                      stat64
syscall 196 FAILED Ox/8a/10080
syscall 220 FAILED Ox/8a/014dc
Suspect module located (0x/89da6d8 – C
FOUND 15 Modified syscall table functions
                                                                                                    Istat64
                                                                                        getdents64
- Oxf8al2000)
WARNING: Found process id 836 removed from the tosk_queue. Launch Path: /root/code/interrogator/demo/trojans/test WARNING: process id 13745 hidden or just exited (tb) Launch Path: /root/code/interrogator/demo/trojans/tb FOUND 2 Hidden process listings
 HIDDEN File found: /mp/hideme
WARNING: File size is 2336990 (should be 2335392): /vor/log/messages
HIDDEN TCP Port Listener found: port 111
HIDDEN TCP Port Listener found: port 139
HIDDEN TCP Port Listener found: port 2222
HIDDEN TCP Port Listener found: port 6000
HIDDEN TCP Port Listener found: port 32768
HIDDEN TCP Port Listener found: port 32769
 [root@localhost interrogator]# exit
```

Fig.20c

```
[root@localhost Interrogator]# ./interrogator
Where would you like the results stored? [/tmp/interrogator/)
Check for hidden TCP port listeners? [Y]
Check for system call patching? [Y]
Check for hidden kernel modules? [Y]
Check for hidden files? (may take > 15 minutes) [N] Y
Running the interrogator... this may take a minute
Results are located at /tmp/interrogator/summary
View results now? [Y]
 206
 WARNING: Deviations found in the sys_call_table syscall[3] FAILED Oxf8all494 read
 syscall[3]
syscall[51
                              FAILED
                                                Oxf8all020
 syscall[11]
syscall[13]
syscall[78]
syscall[141]
                              FAILED
                                                                                    execve
                                                Oxf8all8a0
                                                                                    time
                              FAILED
                                                                                    gettiineofday
                                                Oxf8all83c
                                                Oxf8all544
                                                                                    getdents
 syscall[220]
                              FAILED
                                                Oxf8all6c0
                                                                                    getdents64
Suspect module located (0xf89db6d8 — 0xf8a3f000) FOUND 7 Modified syscall table functions
WARNING: process id 1584 hidden or just exited (tb)
Launch Path: /root/code/interrogator/demo/trojans/tb
FOUND 1 Hidden process listing
HIDDEN File found: /tmp/hideme
WARNING: File size is 1021523 (should be 1020648): /var/log/cron
WARNING: File size is 603820 (should be 603384): /var/log/maillog
 HIDDEN TCP Port Listener found: port 2222
[root@localhost interrogator]# exit
```







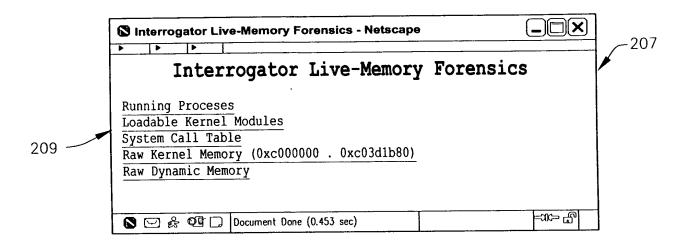


Fig.22b

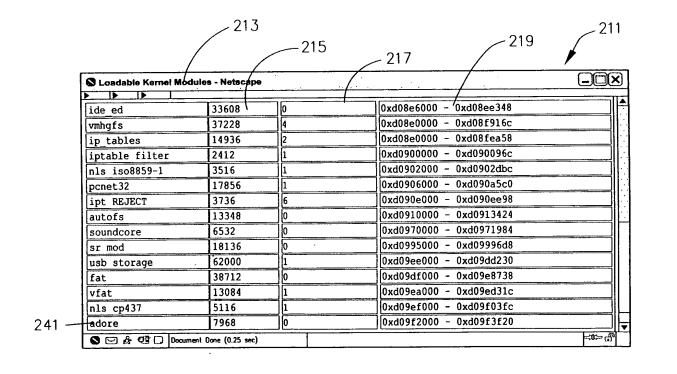


Fig.25b

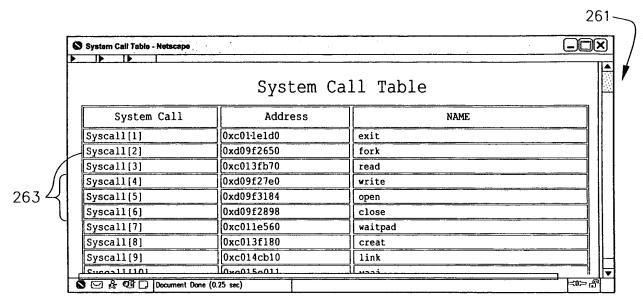


Fig.27b

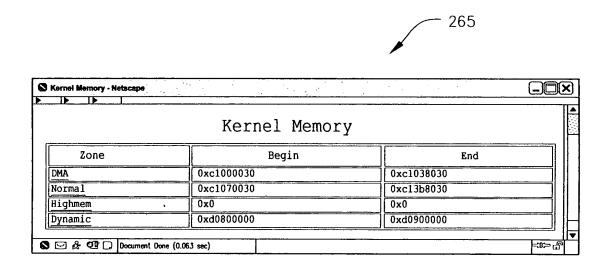


Fig.28b

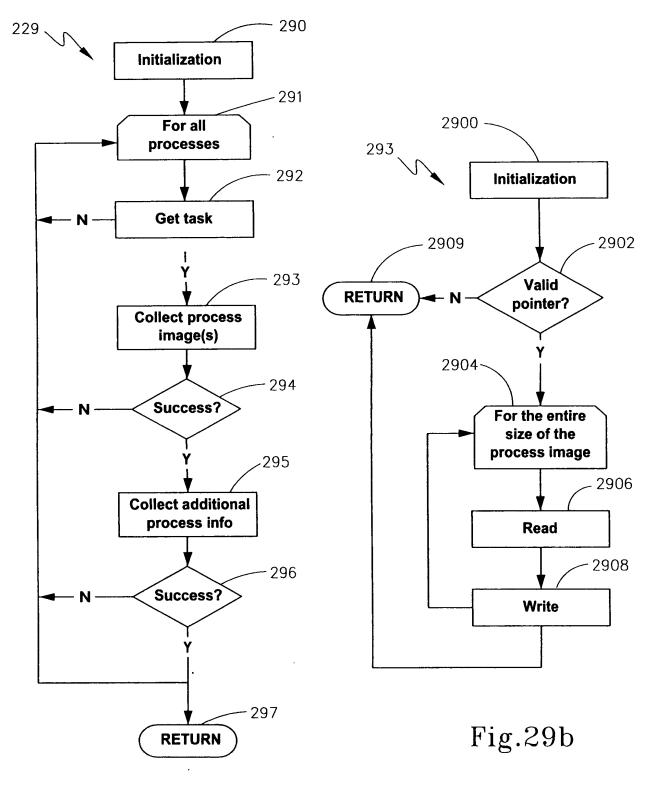
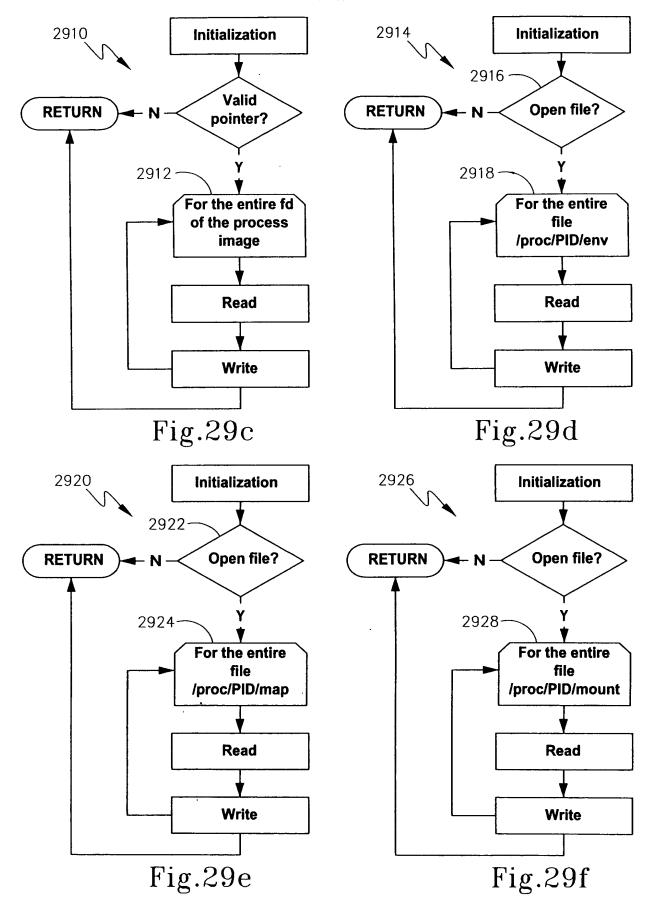


Fig.29a



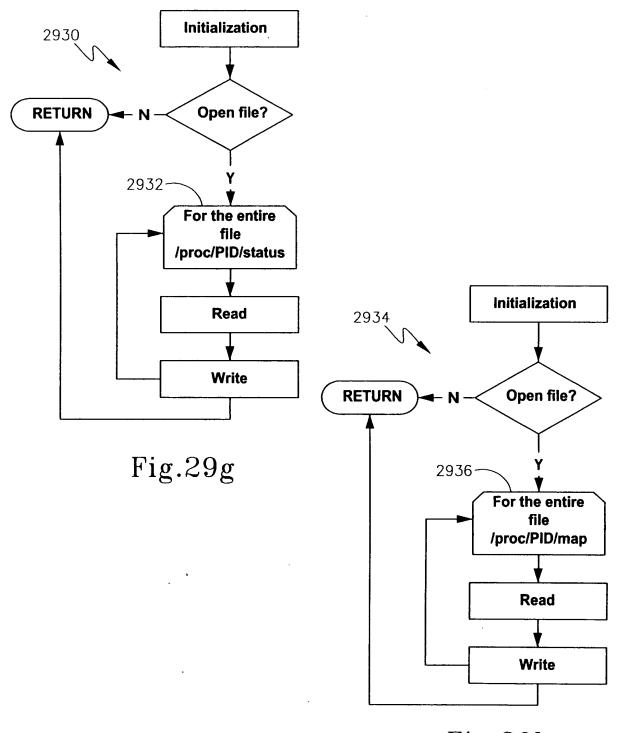


Fig.29h

Loadable Kernel Mod			·	·				
		Runn	ning Proces	ss Listi	ing			
Process	Proc Image	Main Image	File Descriptors	Environment	Mapping	Command	Mounts	Status
init	1	1	0	env	map	command	mount	status
vinware-guestd	327	327	4	env	map	command	mount	status
dhcbent	529	529	3	env	map	command	mount	status
syslogd	582	582	7	env	map	command	mount	status
klogd	586	586	2 .	env	map	command	mount	status
postmap	603	603	5	env	map	command	mount	status
rpc.statd	622	622	7	env	map	command	mount	status
apend	703	703	2	env	map	command	mount	status
sshd	741	741	4	env	map	command	mount	status
xinetd	755	755	6	env	map	command	mount	status
sendmail	778	778	5	env	map	command	mount	status
sendmail	788	788	4	env	map	command	mount	status
gpm	798	798	2	env	map	command	mount	status
crond	807	807	5	env	map	command	mount	status
xts	841	841	6	env	map	command	mount	status
atd	859	859	4	env	тар	command	mount	status
login	868	868	10	env	тар	command	mount	status

267		Fig.29	9i		
267		O			, 269
total 13696					
drwxr-xr-x	2 root	4096	Jan	5	19:41 .
drwxr-xr-x	11 root	4096	Jan	5	22:26
-rwxr-xr-x	1 root	33960	Jan	5	19:40 1.exe
-rwxr-xr-x	1 root	33960	Jan	5	19:40 1.mem exe
-rwxr-xr-x	1 root	103165	Jan	5	19:40 327.exe
-rwxr-xr-x	1 root	103165	Jan	5	19:40 327.mem exe
-rwxr-xr-x	1 root	390950	Jan	5	19:40 529.exe
-rwxr-xr-x	1 root	390950	Jan	5	19:40 529.mem exe
-rwxr-xr-x	1 root	33635	Jan	5	19:40 582.exe
-rwxr-xr-x	1 root	33635	Jan	5	19:40 582.mem exe
-rwxr-xr-x	1 root	28571	Jan	5	19:40 586.exe
-rwxr-xr-x	1 root	28571	Jan	5	19:40 586.mem exe
-rwxr-xr-x	1 root	40144	Jan	5	19:40 603.exe
-rwxr-xr-x	1 root	38147	Jan	5	19:40 603.mem_exe
Fig.30a					
•		•			
		_			

fd:	0	READ-WRITE	/socket:/ (1103)271	1
fd:	1	WRITE-ONLY	/var/log/messages	
fd:	2	WRITE-ONLY	/var/log/secure	
fd:	3	WRITE-ONLY	/var/log/maillog	
fd:	4	WRITE-ONLY	/var/log/cron	
fd:	5	WRITE-ONLY	/var/log/spooler	
fd:	6	WRITE-ONLY	/var/log/boot.log	

Fig.30b

METHODOLOGY, SYSTEM, COMPUTER READABLE MEDIUM, AND PRODUCT PROVIDING A SECURITY SOFTWARE SUITE FOR HANDLING OPERATING SYSTEM EXPLOITATIONS

Applicant: Sandra E. Ring et al. Serial No.: 10/789,460 Docket No.: 2037

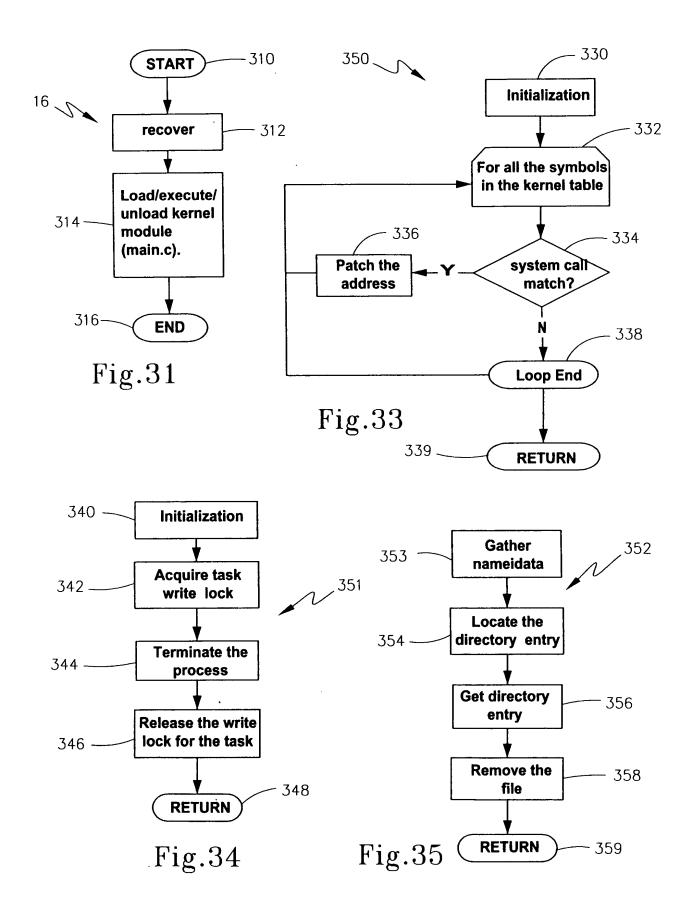
```
SSH AGENT PID=4606
HOSTNAME=string-1.internal.vlan.iwc.sytexinc.com
PVM RSH=/usr/bin/rsh
SHELL=/bin/bash
TERM=xterm
HISTSIZE=1000
GTK RC FILES=/etc/gtc/gtkc:/root//gtkrc-1.2-gnome2
WINDOWID=27270368QTDIR=/usr/lib/qt-3.1
USER=root
LS COLORS=
PVM ROOT=/usr/share/pvm3
SSH AUTH SOCK=/tmp/sh=XX3Bs0yB/agent.4542
SESSION MANAGER=local/sring-1.internal.vlan.iwc.sytexinc.com:/tmp/.ICE-
unix/45\overline{4}2
USERNAME=root
MAIL=/var/spool/mail/root
PATH=/usr/kerberos/sbin:/usr/kerberos/bin:/usr/local/sbin:/usr/local/bin:/sbin
:/bin:/usr/sbin:/usr/bin:/usr/X11R6/bin:/root/bin:usr/local/netscape
INPUTRC=/etc/inputrc
PWD=/root
XMODIFIERS=@im-none
LANG=en US.UTF-8
LAMHELPFILE=/etc/lam/lam-helpfile
GDMSESSION=Default
SH ASKPASS=/usr/libexec/openssh/gnome-ssh-askpass
HOME=/root
SHLVL=2X
PVM ROOT=/usr/share/pvm3/xpvm
GNOME DESKTOP SESSION ID=Default
BASH ENV=/root/.bashrc
LOGNAME=root
LESSOPEN=|/usr/bin/lesspipe.sh %s
DISPLAY=:0.0G
BROKEN FILENAMES=1
COLORTERM=gnome-terminal
XAUTHORITY=/root/.Xauthority =/usr/bin/ssh
                                                      Name:
```

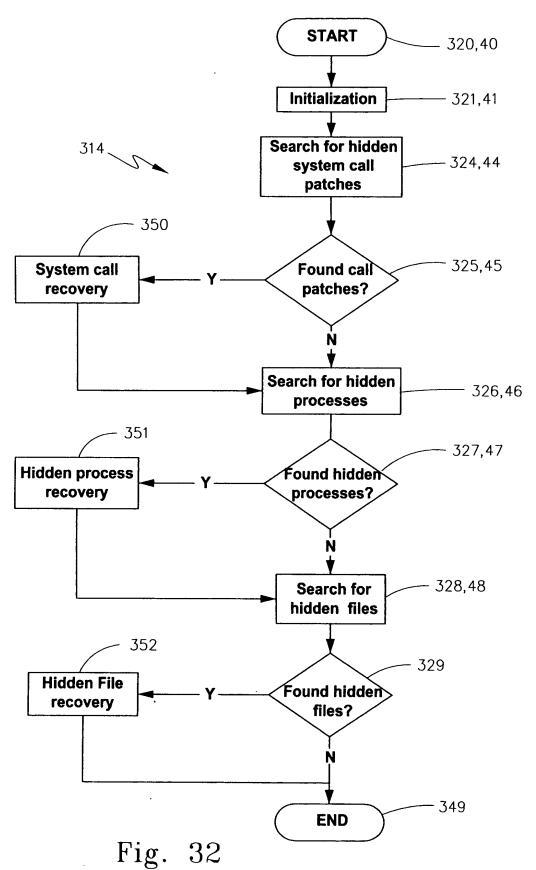
Fig.	30c
------	-----

rootfs / rootfs 0 0 /dev/root / ext3 ro n Ó /proc /proc proc rw 0 0 usbdevfs /proc/bus/usb usbdevfs rw /dev/sdal /boot ext3 rw 0 0 none /dev/pts devpts rw 0 0 none /dev/shm tmpfs rw 0 none /mnt/hgfs vmware-hgfs rw, nosuid, nodev /dev/sdbl /mnt vfat rw 0 0

Fig.30d

vmware-guestd State: R (running) 327 Tgid: Pid: 327 PPid: 1 TracePid: 0 Uid: 0 0 0 0 Gid: 0 0 0 0 FDSize: 32 Groups: 1424 kb VmSize: VmLck: 0kb VmRSS: 444 kb VmData: 48 kb VmStk: 8 kb VmExe: 84 kb VmLib: 1252 kb SigPnd: 0000000000000000 SigBlk: 0000000000000000 SigIgn: 8000000000000000 SigCqt: 0000000000004a07 CapIng: 0000000000000000 CapPrm: 00000000fffffeff CapEff: 00000000fffffeff Docket No.: 2037





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METHODOLOGY, SYSTEM, COMPUTER READABLE MEDIUM, AND PRODUCT PROVIDING A SECURITY SOFTWARE SUITE FOR HANDLING OPERATING SYSTEM EXPLOITATIONS

Applicant: Sandra E. Ring et al. Serial No.: 10/789,460 Docket No.: 2037

Script started on Sun Jan 11 10:18:52 2004 (root@local.host recovery) # ./recovery
Terminate hidden processes? [Y]
Recover system call table? [Y]
Remove hidden files [N] Y
Results are located at /tmp/interrogator/summary
View results now? [Y]

Script done on Sun Jan 11 10:19:03 2004

Fig.36a

Script started on Sun Jan 11 10:31:02 2004 (root@local.host adore)# ./startadore Warning: loading cleaner.o will taint the kernel: no license See http://www.tux.org/lkml/#export-tainted for information about tainted modules Module cleaner loaded, with warnings

(root@localhost adore) # ./ava i 1302
Checking for adore 0.12 or higher ...
Adore 0.42 installed. Good luck.
Made PID 1302 invisible.

(root@localhost adore) # ./ava h /tmp/test
Checking for adore 0.12 or higher ...
Adore 0.42 installed. Good luck.
File '/tmp/test' hided.

(root@localhost adore) # ls /tmp
ssh-XXAbSIW
ssh-XXEZXD3

(root@localhost adore)# ps -ef |grep test
(root@localhost adore)# exit
Script done on Sun Jan 11 10:35:40 2004

Fig.36b

361

360

Fig.36c

Script started on Sun Jan 11 10:35:21 2004 (root@local.host recovery)# /tmp/test Running 1 2 Running 3 Running Running 5 Running Running 7 Running Hangup Script done on Sun Jan 11 10:55:12 2004

Fig.36d

METHODOLOGY, SYSTEM, COMPUTER READABLE MEDIUM, AND PRODUCT PROVIDING A SECURITY SOFTWARE SUITE FOR HANDLING OPERATING SYSTEM EXPLOITATIONS Applicant: Sandra E. Ring et al. Serial No.: 10/789,460 Docket No.: 2037

Script started on Sun Jan 11 10:57:09 2004 [root@localhost recovery]# ls /tmp ssh-XXAbS7W ssh-XXB2XD3

[root@localhost recovery]# sum /tmp/test 03965 12 [root@localhost recovery]# ./recover Terminate hidden processes? [Y] N Recover system call table? [Y] N Delete hidden files? [N] Y Results are located at /tmp/interrogator/summary View results now? [Y] -----[SUMMARY]------

REMOVED /tmp/test

(root@localhost recovery]# ls /tmp ssh-XXAbs7W ssh-XXEZXD3

{root@localhost recovery]# sum /tmp/test sum: /tmp/test: No such file or directory

root@localhost recovery]# exit Script done on Sun Jan 11 10:57:47 2004

Fig.36e

METHODOLOGY, SYSTEM, COMPUTER READABLE MEDIUM, AND PRODUCT PROVIDING A SECURITY SOFTWARE SUITE FOR HANDLING OPERATING SYSTEM EXPLOITATIONS Applicant: Sandra E. Ring et al. Serial No.: 10/789,460 Docket No.: 2037

Script started on Sun Jan 11 10:57:57 2004 [root@localhost recovery] # ./recover Terminate hidden processes? [Y] N Recover system call table? [Y] Delete hidden files? [N] N

Results are located at /tmp/interrogator/summary

View results now? [Y]

```
-----[ SUMMARY ]------
```

WARNING suspect module found: d09cb000 7968 bytes (adore) FOUND 1 HIDDEN module loaded

```
WARNING: Deviations found in the sys call table
          FAILED Oxd09cb650
                                    fork
syscall[2]
            FAILED Oxd09cb7e8
                                    write
syscall[4]
            FAILED Oxd09cc184
syscall[5]
                                    open
                                                - 365
            FAILED Oxd09cb898
syscall[6]
                                    close
syscall[18] FAILED Oxd09cbbe4
                                    stat
                    Oxd09cb710
syscall[37] FAILED
                                    kill /
syscall[39] FAILED Oxd09cb9a0
                                    mkdir
syscall[84] FAILED Oxd09cbcd0
                                    Istat
syscall[106] FAILED Oxd09cbdbc
                                    stat
syscall[107] FAILED Oxd09cbe94
                                    Istat
syscall[120] FAILED Oxd09cb6b0
                                    clone
syscall[141] FAILED Oxd09cb368
                                    getdents
syscall[195] FAILED Oxd09cbf80
                                    stat64
syscall[196] FAILED Oxd09cc080
                                    1stat64
syscall[220] FAILED Oxd09cb4dc
                                    getdents64
RECOVERED 15 Modified syscall table functions
```

METHODOLOGY, SYSTEM, COMPUTER READABLE MEDIUM, AND PRODUCT PROVIDING A SECURITY SOFTWARE SUITE FOR HANDLING OPERATING SYSTEM EXPLOITATIONS

Applicant: Sandra E. Ring et al. Serial No.: 10/789.460 Docket No.: 2037

```
Script started on Sun Jan 11 11:31:47 2004
[root@localhost adore] # ps -ef |grep test
       1284 1258 0 11:31 pts/1
                                  00:00:00 /tmp/test
[root@localhost adore]# ls /tmp
ssh-XXAbS7W
ssh-XXEZXD3
test
[root@localhost adore]# ./startadore
Warning: loading cleaner.o will taint the kernel: no license
See http://www.tux.org/lkml/#export-tainted for information about tainted
modules
Module cleaner loaded, with warnings
[root@localhost adore]# ./ava i 1284
Checking for adore 0.12 or higher ...
Adore 0.42 installed. Good luck.
Made PID 1284 invisible.
[root@localhost adore]# ./ava h /tmp/test
Checking for adore 0.12 or higher ...
Adore 0.42 installed. Good luck.
File '/tmp/test' hided.
(root@localhost adore]# ps -ef |grep test
                                                                   ,366
(root@localhost adore]# ls /tmp
ssh-XXAbS7W
ssh-XXEZXD3
[root@localhost adore]# cd ../interrogator/recovery
[root@localhost recovery]# ./recover
Terminate hidden processes? [Y] N
Recover system call table? [Y] Y
Delete hidden files? [N] N
Results are located at /tmp/interrogator/summary
View results now? [Y]
                   ----[ SUMMARY ]------
WARNING suspect module found: d09cb000 7968 bytes (adore)
FOUND 1 HIDDEN module loaded
WARNING: Deviations found in the sys_call_table
                FAILED Oxd09cb650
syscall[2]
                                         fork
                FAILED
                        0xd09cb7e8
syscall[4]
                                         write
                FAILED Oxd09cc184
syscall[5]
                                         open
syscall[6]
                FAILED Oxd09cb898
                                         close
                FAILED
                        0xd09cbbe4
                                         stat
syscall[18]
syscall[37]
                FAILED
                        Oxd09cb710
                                         kill
syscall[39]
                FAILED Oxd09cb9a0
                                         mkdir
syscall[84]
                FAILED Oxd09cbcd0
                                         Istat
syscall[106]
                FAILED
                        Oxd09cbdbc
                                         stat
syscall[107]
                FAILED
                        Oxd09cbe94
                                         Istat
syscall[120]
                FAILED
                        Oxd09cb6b0
                                         clone
                FAILED
                        Oxd09cb368
syscall[141]
                                         getdents
                        Oxd09cbf80
syscall[195]
                FAILED
                                         stat64
                FAILED
                        Oxd09cc080
syscall[196]
                                         1stat64
                FAILED Oxd09cb4dc
syscall[220]
                                         getdents64
RECOVERED 15 Modified syscall table functions
[root@localhost recovery]# ps -ef |grep test
          1284
               1258 0 11:31 pts/1
                                        00:00:00 /tmp/test
          1345 1288 0 11:33 pts/2
                                        00:00:00 grep test
[root@localhost recovery]# ls /tmp
ssh-XXAbS7W
ssh-XXS2XD3
test
[root@localhost recovery]# exit
```

Script done on Sun Jan 11 11:33:21 2004

Fig.36g